INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

Date..... FN / AN Time : 2 / 3 Hrs. Full Marks : 50 No. of Students : 91

~~Autumn~~ / Spring Semester, ... Deptt. **Electronics & Electrical Communication Engg.** Sub. No. **EC21006**

II[nd] Yr. B.Tech. (H) / B.Arch. (H) / M.Sc. Sub. Name : **Electromagnetic Engngineering**

Instruction : **Answer ALL Questions.** All symbols and variables have their usual meaning.

Markings will be based on details of the steps clearly provided

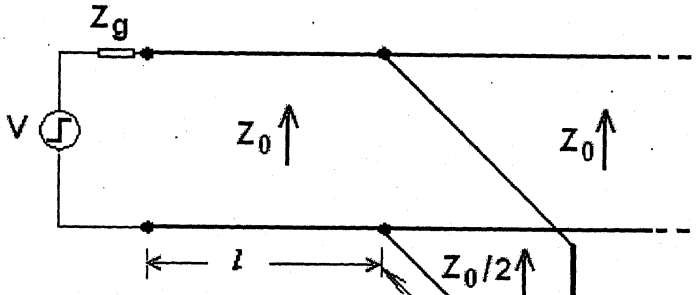
Note 1: The numbers in square brackets at the right-hand side of the text indicate the provisional allocation of maximum marks per question or sub-section of a question.

Note2: You may need: $\varepsilon_0 = 8.854\times10^{-12}\,F/m, \mu_0 = 4\pi\times10^{-7}\,H/m.$

Q.I An air spaced telephone line has the following parameters at **10 KHz**:
R= 28 Ω/Km, G=3 μmho/m (=3μS/Km), **L= 2.4 mH/Km, C= 5 nF/Km.**
Determine the characteristic impedance for the line, phase constant, guide wavelength, attenuation constant and attenuation in **dB/Km.** **[5]**

Q.II A transmission line system is shown. Draw the reflection diagram for $0 < t < 6t_d$ and hence sketch the voltage waveform at the junction.

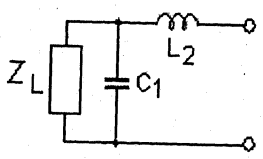
[10]



Q.III

(a) With an unknown load connected to an air transmission line, S=1.8 is recorded and minima are found at 14.2 cm, 64.2 cm, 114.2 cm. When the load is replaced by a short circuit , the minima are at 24.2 cm, 74.2 cm, 124.2 cm. If $Z_0 = 72\ \Omega$, calculate λ, f, and Z_L. **[5]**

(b) Match a load impedance of $Z_L = (150+j100)\ \Omega$. to 50Ω at 100 MHz using lumped elements as per the figure: **[10]**



P.T.O.

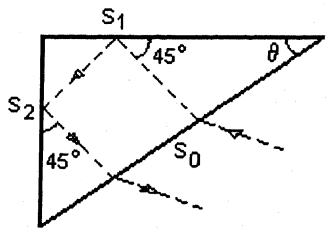
Q.IV (a) Given $\vec{\mathcal{E}} = \hat{x}\, y^3 \sin \omega t$ and $\vec{\mathcal{H}} = \hat{y}\, x^2 \cos \omega t$, determine $\vec{\mathcal{J}}$ and $\vec{\mathcal{M}}$. Determine $\mathcal{I}$ and $\mathcal{I}_m$ through the semi-circular disk $z=0$, $x^2 + y^2 = 4$ and $2 \geq y \geq 0$. [7]

(b) Determine the instantaneous quantities corresponding to:

(i) $I = 5 + j10$, (ii) $\vec{E} = \hat{x}\,(4 + j5) + \hat{y}\,(2 + j3)$,

(iii) $\vec{H} = (\hat{x} + \hat{y})\, e^{-j(x^2+y^2)}$, [3]

Q.V (a) The incident vertically (parallel) polarized radiation from the right is to pass totally into the prism without suffering any reflection at S_0, then be totally reflected at S_1 and S_2, and return parallel to the incident path. Specify the angle θ if the prism is to be constructed from quartz (refractive index= $\sqrt{\varepsilon_r} = 1.56$). Show whether conditions for total reflections are met. [3]



Q.VI Sketch the horizontal radiation pattern of four vertical (short) antennas spaced λ/4 apart and fed with equal currents but with a progressive phase shift of 90° .between elements. [7]

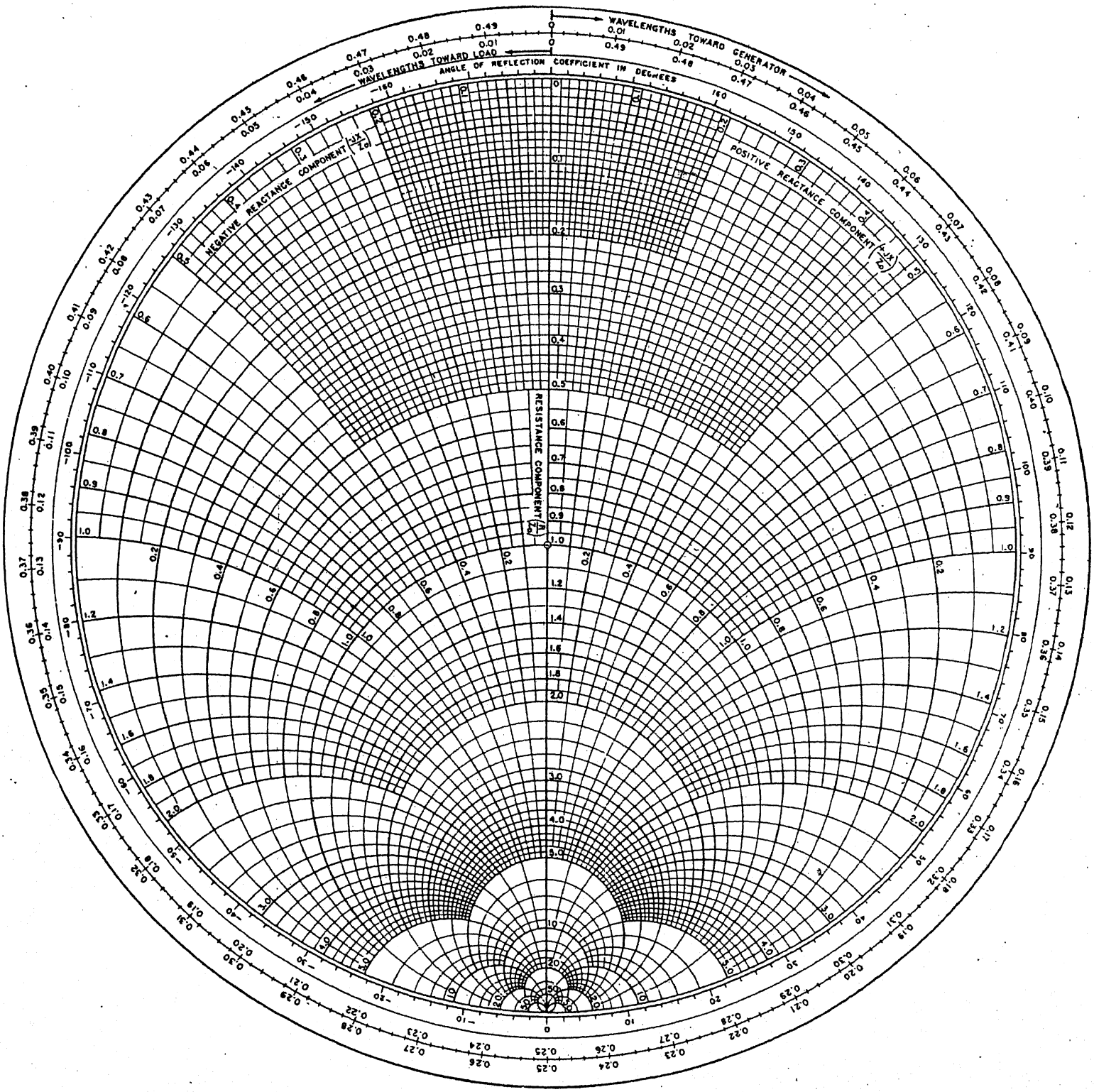
Note3: You may need:

$$Z_z(\text{Hor.} / \perp^r \text{pol.}) = \eta / \cos\theta$$

$$Z_z(\text{Vt.} / \|^l \text{pol.}) = \eta \cos\theta$$

$$\tan \vartheta_B = \sqrt{\frac{\varepsilon_2}{\varepsilon_1}}$$

$$\sin \vartheta_c = \sqrt{\frac{\varepsilon_2}{\varepsilon_1}}$$


WAVELENGTHS TOWARD GENERATOR
WAVELENGTHS TOWARD LOAD
ANGLE OF REFLECTION COEFFICIENT IN DEGREES
POSITIVE REACTANCE COMPONENT (+jX/Z0)
NEGATIVE REACTANCE COMPONENT (-jX/Z0)
RESISTANCE COMPONENT (R/Z0)